sustainability

MDPI

Article

The Impact of Government Subsidies on Private R&D and Firm Performance: Does Ownership Matter in China's Manufacturing Industry?

Zhenji Jin [1], Yue Shang [1] and Jian Xu [2,*]

[1] Department of Management, Qingdao Agricultural University, Qingdao 266109, China; zhenji12@aliyun.com (Z.J.); shangyue59@gmail.com (Y.S.)
[2] Department of Business Administration, Dankook University, Jukjeon-ro 152, Yongin-si, Gyeonggi-do 16809, Korea
* Correspondence: jianxusword@gmail.com

Received: 4 June 2018; Accepted: 26 June 2018; Published: 27 June 2018

check for updates

Abstract: Government subsidies as a policy instrument are used to alleviate market failure in research and development (R&D) activities. We aim to understand the influence of government subsidies on enterprises' R&D investment and performance. We are also interested in examining how the attributes of enterprise ownership act as a moderating variable for the relationship between government subsidies, R&D investment, and firm performance. We use firm-level data on China's manufacturing listed companies from 2011 to 2015. The results show that receiving government subsidies improves private R&D investment and firm performance, and state-owned enterprises (SOEs) can obtain more subsidies than private-owned enterprises (POEs). However, the impact of government subsidies on private R&D investment is stronger in POEs than in SOEs of China. In additional analyses, we also examine this relationship by industry, region, subsidy intensity, and R&D intensity. This study has important policy implications for regulators to improve the effectiveness of government subsidies.

Keywords: government subsidy; R&D investment; firm performance; ownership; manufacturing listed company

1. Introduction

The relationship between government and private investment is still a hot issue in macroeconomics [1] and has attracted the attention of both economists and policy-makers. A key question is whether government subsidy crowds in or crowds out enterprises' investment in research and development (R&D). It also exerts a great influence on their performance and thus long-term sustainable development.

For over three decades, China embarked on a state-led economic development strategy [2]. China's industrialization has been mainly focused on heavy and capital-intensive industries, particularly the manufacturing industry [3]. However, China still trails far behind the United States (for example) with respect to industrialization level. In the context of Industry 4.0, the Chinese government issued a 10-year national plan, *Made in China 2025*, aiming to transform China from a manufacturing giant into a world manufacturing power [4]. Manufacturing enterprises are considered to be the main driving force for economic growth, and therefore should be given special status in government policies. There is no doubt that government spending plays an important role in economic growth [5]. Government subsidies are fundamental for stimulating the activities of manufacturing enterprises, particularly R&D investment. Subsidies of manufacturing enterprises are largely attributed to government R&D funding to encourage enterprises to upgrade their industrial structure and invest in high-tech products.

In the period 2011–2016, the total amount of R&D expenditure in the manufacturing industry increased from 569.53 billion yuan (RMB) in 2011 to 1058.03 billion yuan in 2016 (See Figure 1).[1] Why does the government increase R&D subsidies significantly? How and to what extent do government subsidies in general affect R&D activities and firm performance in the Chinese context? These issues are the subject of intense debate among Chinese scholars and policy-makers.

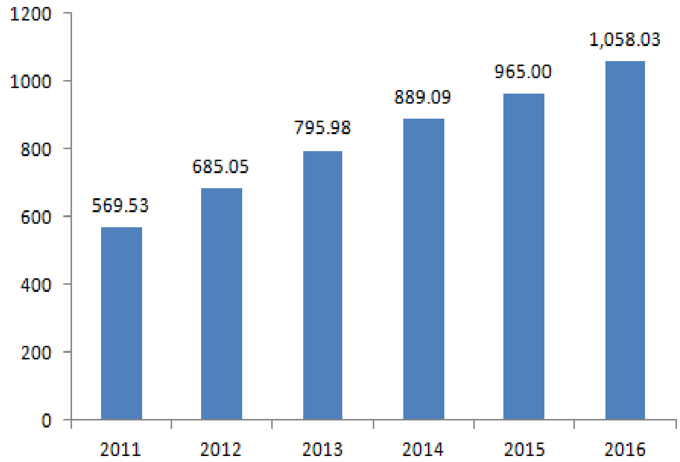

Figure 1. Research and development (R&D) expenditures in China's manufacturing industry from 2011 to 2016 (billion yuan).

Theoretical and empirical results support the crowding-out effect of government subsidies on private R&D investment. Government spending derives from levied taxes. The more taxes imposed by the government, the less income for private enterprises, negatively affecting R&D investment and operating performance [6].[2] However, some scholars believe that government subsidies can improve firms' innovation capability [7–9]. Considering the importance of the manufacturing industry for economic growth, the crowding-out effect of government subsidies on private R&D investment may not be directly applied. It is expected that the empirical results will not hold in China's manufacturing industry.

Different types of ownership are associated with different institutional arrangements, and state-owned enterprises (SOEs), controlled by the government, behave differently from private-owned enterprises (POEs) in utilizing government subsidies [9]. As a typical emerging economy, China has become increasingly diverse in terms of ownership [10]. Yet SOEs still remain dominant in the context of China's economic transition [11]. Studying the different effects of subsidies on SOEs and POEs is especially important.

The contributions of this paper are as follows. First, this study systematically analyzes the relationship between government subsidies, R&D investment, and firm performance in China's manufacturing industry. Current studies mainly focus on developed countries such as the US and the UK, with little attention paid to emerging economies such as China. It is of interest whether government subsidies will advance R&D input and thus improve financial performance in the mixed market where SOEs and POEs have coexisted for a long time. Second, we seek to explore the influence of ownership characteristics on the effectiveness of subsidies. Few studies have explored the effects of ownership on government subsidies. Chinese manufacturing companies inherently have different types of ownership due to the country's unique institutional environment and political background. The amount of government subsidies received by manufacturing companies with different types of ownership may vary greatly. Third, this paper addresses the gap in prior research because of the mixed results of the impact of government subsidies, and enriches the current literature on government subsidies by providing empirical evidence in the Chinese mixed market. This study also investigates the impact of ownership on the relationship between government subsidies, private R&D, and firm performance by industry, region, subsidy intensity, and R&D intensity. The findings of the study provide insights for firm managers to better utilize government subsidies and manage R&D activities. Our findings also have important implications for local officials when they implement policies to ensure the effectiveness of the government's macroeconomic regulation and control.

The paper is structured as follows: In Section 2, a review of the literature is presented and the research hypotheses are developed. Section 3 introduces our data and models. Next, details of tests and results are included in Section 4, and a number of additional analyses are reported in Section 5. Finally, conclusions are discussed.

2. Literature Review and Hypothesis Development

2.1. Relationship between Government Subsidies and R&D Investment

The existing empirical evidence on the relationship between government subsidies and enterprises' private R&D investment is mixed. For instance, Lach [12], based on data from Israeli manufacturing enterprises, confirmed that firms were more likely to increase R&D investment over the long term provided that they can concurrently obtain funding from the government. Empirically, Czarnitzki and Hussinger [13] found that government subsidies directly improved enterprises' R&D input and indirectly led to an increase in intangible assets. Similarly, Lee and Cin [14] pointed out that government subsidies were beneficial to the R&D investment of Korean small and medium-sized enterprises. Jiang et al. [15] found that government subsidies had a significantly positive impact on R&D intensity of China's new energy vehicle enterprises. Other scholars [9,16–20] also found that direct government funding stimulated private R&D investments. In other words, government subsidies can be viewed as an alternative funding source instead of a replacement for private R&D investment. The government can use the "visible hand" to intervene when facing market failure [21]. Government subsidies can reduce the costs and risks of R&D activities, generate financial leverage and spillover effects, and stimulate enterprises' private investment in basic research.[3] Also, government subsidies have a positive effect on product development and new product expansion [22]. Interestingly, some studies found that government subsidies have a negative (i.e., crowding-out) effect [3,23–26] or limited effect [27] on enterprises' R&D investment. Government subsidy, to some extent, is viewed as a tool of government intervention that is likely to lead to a loss of innovative efficiency.

Prior studies [28–31] have also shown that government subsidies usually have a lagging effect on a firm's innovative activities and R&D investment. Therefore, we came to the following hypotheses:

H1. *Government subsidies can induce enterprises' private R&D investment.*

H2. *Lagging government subsidies have a positive impact on R&D investment of enterprises.*

The influence of enterprise ownership on the correlation between government subsidies and internal R&D investment is an issue of great interest and complexity. In America, SOEs are viewed as an extension of the government and its agencies rather than businesses that serve national objectives [31]. However, in China, the aim of SOEs is to maintain control over strategic industries, build them up, and make direct investments [32].

During the economic transition process over the past two decades, China has formed a special institution in which the ownership characteristics of companies directly affect their R&D activities. Compared with other kinds of enterprises (e.g., private enterprises), SOEs even stress how to innovate effectively and efficiently, because they have huge political resources to obtain government subsidies. The relationship between SOEs and the Chinese government is closer than that between POEs and the government [33]. It is argued that close political connections can facilitate access to external innovation resources for Chinese businesses [34]. Moreover, SOEs have more advantages than POEs in promoting regional economic development and increasing employment, so they attract more subsidies from local government [17]. Chinese SOEs receive more subsidies on average than privately controlled firms, because the government makes use of them to pursue sociopolitical objectives such as creating job opportunities and stabilizing local economies [35,36]. Thus, we came to the following hypothesis:

H3. *SOEs can get more government subsidies than private enterprises*.

In the Chinese mixed market, SOEs and POEs have coexisted for a long time, and the two types of enterprises have many differences in resource allocation and financial constraints, leading to different effects of government subsidies.

Government subsidies are pursued by many enterprises. SOEs may provide some false information when applying for government subsidies. Due to the close relationship between SOEs and the government, government officials can help SOEs to conceal facts in some cases [17]. Different from SOEs, private enterprises pay more attention to innovative activities rather than political relations. Once R&D activities fail, it is possible for POEs to lose the opportunity to receive subsidies in the future. Thus, POEs may more effectively utilize government subsidies in case of market failure. Wu [17] confirmed that the same R&D subsidies promote more external investment in POEs than in SOEs. Wang et al. [34] argued that strong formal political connections reduce firm-level R&D intensity. Based on data of Chinese listed firms, Hou et al. [37] found that close government–business relations hinder corporate innovation activities and reduce innovation efficiency. Arqué-Castells [38] argued that the inducement effects of R&D subsidies among small firms are larger than those among large firms. Therefore, we propose the following hypothesis:

H4. *The impact of government subsidies on R&D investment in SOEs is weaker than in POEs. That is, the same government subsidies promote more internal R&D investment in POEs than in SOEs*.

2.2. Relationship between Government Subsidies and Firm Performance

From the perspective of rent-seeking, the granting of subsidies is not based on a firm's promising prospects or social contribution, so it follows that subsidies are not beneficial to company performance. Most scholars state that government subsidies do not improve, but, on the contrary, lower corporate performance. Beason and Weinstein [39] and Bergström [40] analyzed investment subsidy effects and found that government subsidies lead to low growth of enterprises and a decline in return to scale. Based on data from the Greek food and drinks manufacturing sector during 1982–1996, Tzelepis and Skuras [41] proved the negative and insignificant effects of subsidization on the efficiency measure. Employing a database of Chinese listed companies from 2002 to 2004, Tang and Luo [42] found that subsidies did not remarkably facilitate the economic performance of these firms. McKenzie and Walls [43] and Sun and Gan [44] also drew the same conclusion, namely that government subsidies exert no effect on corporate performance.

On the other hand, some studies suggest that government subsidies (e.g., financial appropriation, finance discounts, and tax refunds) may positively affect corporate performance. For instance, Zang [30] identified a positive correlation between current and lagging government subsidies and the performance of China's cultural companies. Likewise, taking China's renewable energy manufacturing companies between 2007 and 2010 as samples, Zhang et al. [45] showed that lagging subsidies have a positive effect on firms' financial performance. By analyzing a sample of Chinese manufacturing firms, Lee et al. [46] found that government subsidies are positively related to firm value. Desai and Hines [47] and Girma et al. [48] also confirmed that subsidies can improve firm profitability. Yang [49] reported that firms benefit from government subsidies as their production costs decrease and production scales increase, thus creating larger net profits. Using financially distressed firms in China as a sample, Tao et al. [50] found that politically connected firms received more government subsidies, which in turn enhanced firm value. Jacob et al. [51] found that fund performance decreased substantially following the phase-out of tax subsidies for Canadian labor-sponsored venture capital corporations, indicating that government subsidies in Canada have a positive effect on firm performance. In addition, if government subsidies result in a lower cost of debt, then the savings in interest and reduced cost of raising capital should also have a positive impact on firm performance [52].

In the context of China's manufacturing power strategy,[4] the government will increase subsidies to manufacturing listed companies, thus improving corporate performance. A study conducted by Zhang et al. [53] showed that both indirect and noninnovative subsidies had significant effects on the financial performance of renewable energy companies in China. In theory, government subsidies can be seen as a form of long-term investment in enterprises' R&D activities and cannot immediately affect innovation performance. Einiö [54] showed that R&D subsidies have a positive impact on productivity after three years of firms entering R&D programs. Based on the above consideration, we formulated the following hypotheses:

H5. *Government subsidies can improve firm performance.*

H6. *Lagging government subsidies have a positive impact on firm performance.*

Many studies [55,56] have concluded that innovation capability can contribute to firm performance. To obtain government subsidies, POEs are more likely to engage in high-technology activities to compete with SOEs. Once these R&D achievements are transferred into productivity, they will, to a greater extent, improve the profitability of POEs. In addition, compared with POEs, SOEs are believed to have low operating efficiency, with some deficiencies in internal management, which adversely affects firm performance. Shleifer and Vishny [57] and Megginson and Netter [58] reported that government-owned firms are less effective and efficient than POEs. Saeed et al. [59] reported that firms with strong political connections tended to have poor performance. Ling et al. [60], using a sample of 103 listed real estate firms during 1998–2012, found that firms with stronger political connections were more likely to exhibit lower profitability. This leads to our seventh hypothesis:

H7. *The impact of government subsidies on firm performance in SOEs is weaker than in POEs.*

3. Research Method

3.1. Sample

We used the China Stock Market Accounting Research (CSMAR) and RESSET financial databases to collect information on all manufacturing companies listed on the Shanghai and Shenzhen stock exchanges from 2011 to 2015. We eliminated companies with no R&D activities for 5 consecutive years and missing information,[5] companies listed after 2011, and companies issuing other kinds of shares, such B, H, S, ADR, etc.[6] As a result, our final sample comprised 879 manufacturing listed companies from 2011 to 2015, for a total of 4395 observations. We used the panel data technique to analyze the data.

Panel A of Table 1 reports the composition of our sample by industry. The sample exhibits some concentration of observations in chemical raw material and chemical products, medicines, special-purpose machinery, electrical machinery and equipment, and computers, communications, and other electronic equipment industries (9.67%, 10.24%, 7.05%, 10.58%, and 13.99% of the sample, respectively). Panel B demonstrates the composition of our sample by ownership. Due to a series of policies to encourage the development of POEs, their number is increasing rapidly within the current economic transition period. In addition, there is no doubt that SOEs still play a critical role in China's manufacturing industry.

Table 1. Distribution of sample firms.

Panel A: Distribution of Sample Firms by Industry		
Industry Sector	**Number of Firms**	**Percent of Sample (%)**
Processing of food from agricultural products	21	2.39
Foods	14	1.59
Wine, drinks, and refined tea	14	1.59
Textiles	22	2.50
Textile wearing apparel and finery	17	1.93
Leather, fur, feathers, and their products and footwear	2	0.23
Processing of timber, manufacturing of wood, bamboo, rattan, palm, and straw products	5	0.57
Furniture	2	0.23
Paper and paper products	18	2.05
Printing and reproduction of recorded media	4	0.46
Culture, education, arts and crafts, sport, and entertainment goods	6	0.68
Processing of petroleum, cooking, and nuclear fuel	7	0.80
Chemical raw materials and chemical products	85	9.67
Medicines	90	10.24
Chemical fibers	14	1.59
Rubber and plastic	24	2.73
Nonmetallic mineral products	27	3.07
Processing of ferrous metals	20	2.28
Manufacturing and processing of nonferrous metals	41	4.66
Metal products	28	3.19
General-purpose machinery	54	6.14
Special-purpose machinery	62	7.05
Automotive	54	6.14
Railroad, marine, aerospace, and other transportation equipment	21	2.39
Electrical machinery and equipment	93	10.58
Computer, communications, and other electronic equipment	123	13.99
Measuring instruments	6	0.68
Other manufacturing	5	0.57
Total	879	100
Panel B: Distribution of Sample Firms by Ownership		
Company Ownership	**Number of Firms**	**Percent of Sample (%)**
State-owned enterprises	310	35.27
Private-owned enterprises	569	64.73
Total	879	100

3.2. Variables

As dependent variables, we consider R&D intensity and return on assets (ROA), measures used in other studies dedicated to analyzing R&D investment and firm performance.[7]

As do other studies, for an independent variable we consider subsidy intensity, given by the ratio of government subsidies in general to total assets. In terms of the impact of ownership attributes, we consider a dummy variable with a value of 1 if the enterprise is state-owned and 0 if it is not; the dummy variable is subsequently multiplied by subsidy intensity.

By drawing on current references [9,17,29,33,45], we consider the following as control variables: (1) size, given by the logarithm of assets; (2) debt, given by the ratio of total short- and long-term debt to total assets; (3) employee, given by the logarithm of number of employees; and (4) age, given by the logarithm of years the firm has been in existence from its founding up to a given time.

Empirical evidence [12,28,61] shows that firm size has a positive impact on R&D investment and firm performance. Hence, we expected a positive relationship between firm size and R&D investment and between firm size and firm performance. Firms with high debt ratio are less likely to engage in R&D activities. It is generally believed that human capital is a key factor affecting R&D activities [62]. Older firms have more profitability and opportunities to engage in R&D activities. Younger firms tend to suffer from financial constraints, so their desire for R&D subsidies is greater than that of older firms. In summary, definitions of the variables are presented in Table 2.

Table 2. Definitions of variables.

Variable	Definition
ROA	Return on assets of enterprise
RD	Ratio of R&D expenditures to total sales
Sub_t	Ratio of government subsidies to total assets in the period t
Sub_{t1}	Ratio of government subsidies to total assets in the first lagged period of period t
Sub_{t2}	Ratio of government subsidies to total assets in the second lagged period of period t
Own	Dummy variable that takes 1 if enterprise is state-owned, 0 otherwise
Size	Logarithm of total assets
Lev	Ratio of total liabilities to total assets
Staff	Logarithm of number of employees
Age	Logarithm of years since setup of enterprise

3.3. Model

For H1 and H5, we employ models (1) and (2), taking RD and ROA as the dependent variables, respectively.

$$RD_{i,t} = \beta_0 + \beta_1 Sub_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 Staff_{i,t} + \beta_5 Age_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$ROA_{i,t} = \beta_0 + \beta_1 Sub_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 Staff_{i,t} + \beta_5 Age_{i,t} + \varepsilon_{i,t} \quad (2)$$

To test H2 and H6, we introduce two lag variables, $Sub_{t\text{-}1}$ and $Sub_{t\text{-}2}$, that have been used in previous studies [17,29,30,45]. Specifically, R&D investment and firm performance in year *t* are influenced by government subsidies in previous years: *t*1 and *t*2.

$$RD_{i,t} = \beta_0 + \beta_1 Sub_{i,t1} + \beta_2 Sub_{i,t2} + \beta_3 Size_{i,t} + \beta_4 Lev_{i,t} + \beta_5 Staff_{i,t} + \beta_6 Age_{i,t} + \varepsilon_{i,t} \quad (3)$$

$$ROA_{i,t} = \beta_0 + \beta_1 Sub_{i,t1} + \beta_2 Sub_{i,t2} + \beta_3 Size_{i,t} + \beta_4 Lev_{i,t} + \beta_5 Staff_{i,t} + \beta_6 Age_{i,t} + \varepsilon_{i,t} \quad (4)$$

For H4 and H7, models (5) and (6) are carried out to examine how government subsidies influence an enterprise's R&D investment and performance under different types of ownership. A negative coefficient of the interaction of ownership type and government subsidies (β_2) is expected in models (5) and (6), respectively:

$$RD_{i,t} = \beta_0 + \beta_1 Sub_{i,t} + \beta_2 Sub_{i,t} * Own_{i,t} + \beta_3 Size_{i,t} + \beta_4 Lev_{i,t} + \beta_5 Staff_{i,t} + \beta_6 Age_{i,t} + \varepsilon_{i,t} \quad (5)$$

$$ROA_{i,t} = \beta_0 + \beta_1 Sub_{i,t} + \beta_2 Sub_{i,t} * Own_{i,t} + \beta_3 Size_{i,t} + \beta_4 Lev_{i,t} + \beta_5 Staff_{i,t} + \beta_6 Age_{i,t} + \varepsilon_{i,t} \quad (6)$$

where $i = 1, \ldots n$ and $t = 1, \ldots t$ represent firm and year, respectively; β_0, β_1, β_2, β_3, β_4, β_5, and β_6 are the presumed parameters; and ε denotes the measurement error term.

For H3, the mean differences in government subsidies under different ownership types are analyzed by *t*-test. The *t*-test can be used, for example, to determine if two sets of data are significantly different from each other. In this study, we use models (1)–(6) to examine the differential effects of government subsidies on enterprises' R&D investment and performance.

4. Results

4.1. Descriptive Statistics

Descriptive statistics are shown in Table 3. In panel A of Table 3, the mean value of ROA is 0.0414, which implies that China's manufacturing enterprises can effectively use their assets to generate earnings. The mean value of R&D investment is 3.46%, indicating that investment in R&D activities is at a relatively low level compared with the current sales revenue of enterprises. The mean value of Sub is 0.66%, indicating that subsidy intensity is also at a low level. Finally, the mean value of Own confirms the fact that about 35% of our sample consists of state-owned manufacturing enterprises.

Panel B demonstrates the means of the variables under different types of ownership. We find that, on average, the performance of POEs is better than SOEs. POEs have, on average, greater R&D intensity than SOEs. The results show that the rate of government subsidies of SOEs to total assets is 0.0070, and that of POEs is 0.0064, which indicates that there are significant differences between SOEs and POEs under 1% of the significance level (t = 1.863). The government puts limited government subsidy resources into supporting SOEs with R&D activities. SOEs can obtain more government subsidies than POEs, supporting H3. We also find that SOEs, on average, are larger, have more debt, have more employees, and are older than POEs.

Table 3. Descriptive statistics.

Panel A: Descriptive Statistics of Full Sample				
Variable	**Mean**	**Standard Deviation**	**Min**	**Max**
ROA	0.0414	0.0686	−0.7765	1.2162
RD	0.0346	0.0409	0	1.6943
Sub	0.0066	0.0102	0	0.2248
Size	9.5210	0.4532	8.2854	11.8651
Lev	0.4209	0.2079	0.0075	2.3940
Staff	3.4140	0.4355	1.4472	5.2144
Age	1.1682	0.1372	0.4771	1.7559
Own	0.35	0.478	0	1
Panel B: Descriptive Statistics of SOEs and POEs				
Variable (Mean)	**SOEs (Own = 1)**	**POEs (Own = 0)**	**Difference *t*-Statistic**	
ROA	0.0289	0.0482	−9.004	
RD	0.0310	0.0365	−4.305 **	
Sub	0.0070	0.0064	1.863 ***	
Size	9.7050	9.4207	20.833 ***	
Lev	0.5051	0.3751	20.756 ***	
Staff	3.5876	3.3194	20.403 ***	
Age	1.1885	1.1571	7.298 ***	

Notes: ** $p < 0.05$, *** $p < 0.01$.

4.2. Correlation Analysis

A correlation analysis was conducted before regression. Table 4 shows that all the absolute values of correlation coefficients between variables are less than 0.6, illustrating that serious multi-collinearity does not exist among variables. We compute the variance inflation factors (VIFs) and find most to be less than 2, suggesting that multi-collinearity is not a major issue in our study.

Table 4. Correlation coefficients.

Variables	ROA	RD	Sub	Size	Lev	Staff	Age	Own
ROA	1							
RD	−0.010	1						
Sub	0.006	0.106 ***	1					
Size	0.010	−0.112 ***	−0.073 ***	1				
Lev	−0.409 ***	−0.177 ***	0.019	0.412 ***	1			
Staff	0.033 **	−0.146 ***	−0.026 **	0.580 ***	0.388 ***	1		
Age	−0.061 ***	−0.027 **	0.013	0.077 ***	0.112 ***	0.097 ***	1	
Own	−0.135 ***	−0.065 ***	0.028 **	0.300 ***	0.299 ***	0.294 ***	0.088 ***	1

Notes: ** $p < 0.05$, *** $p < 0.01$.

4.3. Estimation Results

The final regression results are presented in Tables 5 and 6.

The results in Table 5 lend support to H1, H2, and H5. The coefficient for government subsidies and R&D investment in the current period is 0.442. This result means that if the government increases subsidies by 1%, manufacturing enterprises are likely to increase their R&D investment by 0.442%. Moreover, a lagging positive (i.e., incentive) effect is found at the 1% and 10% levels: an increase in government subsidies by 1% in periods $t1$ and $t2$ will result in a 0.470% and 0.174% increase in private R&D investment in period t, respectively. The estimated coefficient Sub × Own is negative and significant at the 10% level, which indicates that POEs have a stronger correlation between government subsidies and private R&D than SOEs, consistent with Wu's finding [17]. Compared with POEs, the relatively large amount of subsidies received by SOEs increases business revenue and lessens their intention to pursue innovative strategies.

Table 5. Regression results of models (1), (3), and (5).

Variables	Predicted Sign	Model (1)	Model (3)	Model (5)
Constant		0.035 ** (2.111)	0.047 * (1.794)	0.031 * (1.915)
Sub_t	+	0.442 *** (7.423)		0.558 *** (6.590)
Sub_{t1}	+		0.470 *** (4.271)	
Sub_{t2}	+		0.174 * (1.780)	
Sub × Own	−			−0.199 * (−1.934)
Size	+	0.006 ** (2.564)	0.006 * (1.680)	0.006 *** (2.672)
Lev	−	−0.030 *** (−9.363)	−0.024 *** (−4.820)	−0.030 *** (−9.182)
Staff	+	−0.012 *** (−5.561)	−0.014 *** (−3.960)	−0.012 *** (−5.528)
Age	−	−0.001 (−0.167)	−0.009 (−1.156)	−0.001 (−0.160)
N		4395	2637	4395
F		47.322 ***	17.189 ***	40.083 ***
$Adj.R^2$		0.050	0.036	0.051

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; t-values are in parentheses.

From Table 6, the coefficient of Sub on ROA is highly significant, and, as expected, government subsidies positively impact the performance of manufacturing enterprises. The coefficients of Sub_{t1} and Sub_{t2} are 0.061 and −0.017, respectively, neither of which is significant at the 5% level. Therefore, H6 is not fully supported. In addition, the coefficient of Sub × Own is also nonsignificant, indicating that there is no difference in the impact of government subsidies on firm performance for SOEs and POEs.

Regarding the relationships between the other determinants considered and R&D intensity, we find that (1) firm size is a positive determinant of R&D intensity, and (2) debt and number of employees are restrictive determinants of R&D intensity. However, turning to ROA, we find that (1) size and number of employees are positive determinants of firm performance, and (2) high debt ratio contributes to diminished performance.

Further, we seek to analyze to what extent government subsidies positively impact enterprises' R&D investment and performance under different types of ownership. We can split the whole sample into two subsamples (SOEs and POEs) and re-estimate models (1) and (2).

As Table 7 illustrates, a 1% increase in government subsidies leads to a 33.1% and 58.7% increase in private R&D investment for SOEs and POEs, respectively. Therefore, H1 and H4 are further supported. It is worth noting that the coefficient of Sub on ROA in SOEs (β_1 = 0.245, t = 1.846) is greater than that in POEs (β_1 = 0.128, t = 0.988). This means that the impact of government subsidies on firm performance in SOEs is stronger than in private enterprises.

Table 6. Regression results of models (2), (4), and (6).

Variable	Predicted Sign	Model (2)	Model (4)	Model (6)
Constant		−0.108 *** (−4.314)	−0.174 *** (−5.188)	−0.111 *** (−4.443)
Sub_t	+	0.186 ** (2.056)		0.327 ** (2.532)
Sub_{t1}	+		0.061 (0.427)	
Sub_{t2}	+		−0.017 (−0.138)	
Sub × Own	−			−0.240 (−1.529)
Size	+	0.016 *** (4.920)	0.019 *** (4.442)	0.017 *** (5.000)
Lev	−	−0.168 *** (−34.145)	−0.175 *** (−26.831)	−0.167 *** (−33.920)
Staff	+	0.024 *** (6.949)	0.026 *** (5.973)	0.024 *** (6.975)
Age	−	−0.015 ** (−2.161)	0.007 (0.703)	−0.015 ** (−2.156)
N		4395	2637	4395
F		241.598 ***	123.678 ***	201.783 ***
Adj.R^2		0.215	0.218	0.215

Notes: ** $p < 0.05$, *** $p < 0.01$. t-Values are in parentheses.

Table 7. Regression results of models (1) and (2) by ownership.

	SOEs (Own = 1)		POEs (Own = 0)	
Variable	**Model (1)**	**Model (2)**	**Model (1)**	**Model (2)**
Constant	0.016 (0.478)	−0.069 * (−1.661)	0.044 *** (2.633)	−0.211 *** (−6.386)
Sub	0.331 *** (3.055)	0.245 * (1.846)	0.587 *** (9.024)	0.128 (0.988)
Size	0.011 ** (2.357)	0.012 ** (2.045)	0.003 (1.474)	0.027 *** (6.407)
Lev	−0.024 *** (−3.266)	−0.169 *** (−18.738)	−0.034 *** (−11.467)	−0.160 *** (−27.296)
Staff	−0.022 *** (−3.864)	0.022 *** (3.168)	−0.008 *** (−4.441)	0.025 *** (6.480)
Age	−0.005 (−0.434)	−0.010 (−0.675)	0.0005 (0.131)	−0.014 * (−1.860)
N	1550	1550	2845	2845
F	9.391 ***	71.560 ***	55.893 ***	164.071 ***
Adj. R^2	0.026	0.186	0.088	0.223

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *t*-Values are in parentheses.

4.4. Robustness Check

To test the robustness of the empirical evidence obtained, first we consider Tobin's q to be an alternative measure of firm performance. Then we use the ratio of R&D expenditure to total assets to remeasure RD. Similarly, subsidy intensity is replaced by the ratio of government subsidies to total sales. The regression results are consistent with the basic results. To sum up, the conclusion of this paper is robust.

5. Additional Analyses

Additional analyses are conducted to extend the models discussed earlier by reestimating models (5) and (6).

5.1. Analysis by Industry

Prior studies have shown that the effect of government subsidies on enterprises' R&D investment varies across industries. We choose firms in five industries observed in Section 3.1 as the subsamples[8] and exclude firms in other industries due to the lack of sample size. The results are shown in Table 8.

The results presented in Table 8 reveal that H4 and H7 are supported only in the medicine industry. This is because private investment is the main funding source for pharmaceutical R&D in China. Private pharmaceutical enterprises tend to more effectively utilize funding provided by the government to reduce R&D costs and improve firm performance [63].

In addition, the positive relationship between government subsidies and private R&D is found in the medicine, electrical machinery and equipment, and communications and other electronic equipment industries; the positive impact of government subsidies on firm performance is found in the medicine, special-purpose machinery, and communications and other electronic equipment industries.

Table 8. Regression results of models (5) and (6).

	Chemical Raw Material and Chemical Products		Medicine		Special-Purpose Machinery		Electrical Machinery and Equipment		Communications and Other Electronic Equipment	
Variable	**Model (5)**	**Model (6)**	**Model (5)**	**Model (6)**	**Model (5)**	**Model (6)**	**Model (5)**	**Model (6)**	**Model (5)**	**Model (6)**
Constant	0.092 *** (4.142)	−0.111 (−1.530)	0.002 (0.061)	−0.170 * (−1.910)	−0.046 (−1.301)	−0.166 * (−1.851)	0.077 * (1.925)	−0.094 (−1.462)	−0.143 (−1.401)	−0.189 ** (−2.399)
Sub	−0.038 (−0.290)	0.335 (0.775)	0.543 *** (3.291)	1.052 ** (2.105)	0.276 (1.295)	1.502 *** (2.813)	0.640 *** (5.055)	0.089 (0.437)	0.923 ** (2.223)	0.671 ** (2.088)
Sub × Own	0.112 (0.803)	−0.147 (−0.323)	−0.559 *** (−3.095)	−1.238 ** (−2.264)	−0.321 (−1.372)	−0.937 (−1.599)	−0.275 (−0.717)	−0.432 (−0.703)	0.610 (1.148)	0.515 (1.251)
Size	−0.004 (−1.251)	0.026 ** (2.580)	0.007 * (1.802)	0.029 ** (2.498)	0.015 *** (3.034)	0.021* (1.727)	−0.005 (−0.930)	0.006 (0.780)	0.041 *** (3.030)	0.025 ** (2.351)
Lev	−0.021 *** (−4.964)	−0.157 *** (−11.217)	−0.028 *** (−5.379)	−0.142 *** (−8.955)	−0.038 *** (−6.381)	−0.133 *** (−8.984)	−0.048 *** (−5.865)	−0.141 *** (−10.672)	−0.021 (−1.078)	−0.148 *** (−9.975)
Staff	−0.010 *** (−3.014)	0.016 (1.569)	−0.003 (−0.724)	0.001 (0.105)	−0.013 ** (−2.587)	0.036 *** (2.823)	0.004 (0.865)	0.038 *** (4.599)	−0.050 *** (−4.006)	0.022 ** (2.291)
Age	0.008 (1.494)	−0.078 *** (−4.555)	−0.016 * (−1.792)	0.011 (0.410)	0.006 (0.597)	−0.063 ** (−2.509)	0.009 (1.039)	0.010 (0.745)	−0.013 (−0.593)	−0.025 (−1.427)
N	425	425	450	450	310	310	465	465	615	615
F	19.759 ***	28.454 ***	9.007 ***	17.213 ***	9.199 ***	19.128 ***	13.433 ***	22.667 ***	5.483 ***	22.071 ***
Adj. R^2	0.210	0.280	0.097	0.178	0.137	0.260	0.139	0.219	0.042	0.171

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. t-Values are in parentheses.

5.2. Analysis by Region

Since China is such a large emerging country, subsidy distribution in different subsectors, as well as in different provinces, varies widely. Guided by prior research [64], we divide our sample into three subsamples[9] to reexamine models (5) and (6). Over more than 20 years, the level of economic development in eastern regions has reached the standard of moderately developed, even developed, countries far beyond middle and western regions.[10] With the implementation of the great western development strategy, the Chinese government has made massive investments in western regions. Descriptive statistics of Table A2 show that the subsidy intensity of the central provinces is 0.74%, which is higher than the average of 0.66%, and is 0.65% and 0.57%, respectively, for eastern and western provinces of China.

In Table 9, there appears to be a positive relationship between government subsidies and R&D investment for eastern and central provinces but not for western provinces at all, consistent with Fan and Han [65]. In the case of western provinces, it is interesting to note that government subsidies crowd out private R&D investment. Additionally, H7 is supported only in central provinces. In eastern provinces, it is found that the impact of government subsidies on private R&D in SOEs is weaker than it is in private enterprises. The following are two explanations. First, eastern SOEs and POEs with advanced management experience and complete internal governance can more effectively and efficiently utilize government subsidies to improve innovation efficiency than central and western ones. Second, the imbalance of economic development in China's eastern, central, and western regions has led to a significant difference in input-output efficiency, which in turn indirectly affects government subsidies for SOEs and POEs.

Table 9. Regression results of model (5) and (6).

	Eastern Provinces		Central Provinces		Western Provinces	
Variable	**Model (5)**	**Model (6)**	**Model (5)**	**Model (6)**	**Model (5)**	**Model (6)**
Constant	0.043 *** (2.864)	−0.148 *** (−4.709)	0.030 (1.107)	−0.155 ** (−2.364)	−0.057 (−0.730)	−0.013 (−0.173)
Sub	0.683 *** (9.502)	0.282 * (1.878)	0.326 ** (2.405)	0.396 (1.611)	−0.191 (−0.306)	0.657 (1.134)
Sub × Own	−0.226 ** (−2.440)	−0.052 (−0.269)	−0.212 (−1.425)	−0.468 * (−1.730)	1.063 (1.501)	−0.893 (−1.357)
Size	0.004 * (1.795)	0.020 *** (4.815)	0.006 (1.540)	0.019 *** (2.904)	0.018* (1.673)	0.007 (0.736)
Lev	−0.034 *** (−11.727)	−0.182 *** (−29.860)	−0.031 *** (−6.192)	−0.155 *** (−16.959)	−0.0003 (−0.019)	−0.110 *** (−7.048)
Staff	−0.008 *** (−3.841)	0.026 *** (6.300)	−0.012 *** (−3.300)	0.028 *** (4.426)	−0.034 *** (−2.778)	0.009 (0.784)
Age	−0.004 (−0.961)	−0.009 (−1.127)	0.001 (0.116)	−0.053 *** (−3.560)	0.028 (1.015)	−0.003 (−0.116)
N	2930	2930	835	835	630	630
F	57.114 ***	154.154 ***	13.358 ***	55.844 ***	2.185 **	9.318 ***
Adj.R^2	0.103	0.239	0.082	0.283	0.011	0.074

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. t-Values are in parentheses.

5.3. Analysis by Subsidy Intensity

In order to further examine the influence of government subsidies, we divide the sample into two groups, low subsidy intensity and high subsidy intensity. Descriptive statistics in Table A3 show that the average intensity of government subsidies for the low-intensity group and the high-intensity group is 0.0019 and 0.0113, respectively, and average ROA is similar in both groups, 0.0408 and 0.0420, respectively. However, there is a great difference in average RD: 0.0288 for the low-intensity group and 0.0404 for the high-intensity group.

As Table 10 illustrates, the coefficients of Sub on ROA in both groups are positive and significant, which suggests that government subsidies improve the performance of manufacturing enterprises regardless of the level of subsidy intensity. It is noticeable that the coefficient of Sub on RD in the low subsidy intensity group is greater than that in the high subsidy intensity group, which indicates that the government should rationally readjust subsidy policy to stimulate private R&D input.

The coefficients of Sub × Own are significant and negative in the second and fourth columns of Table 10, whereas they are found to be nonsignificant in the first and third columns. The former findings suggest that the impact of government subsidies on firm performance in SOEs is weaker than in private enterprises regardless of subsidy intensity.

Table 10. Regression results of models (5) and (6).

	Low Subsidy Intensity		**High Subsidy Intensity**	
Variable	**Model (5)**	**Model (6)**	**Model (5)**	**Model (6)**
Constant	0.043 * (2.106)	−0.038 (−1.024)	−0.003 (−0.130)	−0.213 *** (−6.335)
Sub	2.538 *** (2.839)	4.174 *** (2.926)	0.270 *** (3.012)	0.453 *** (3.516)
Sub × Own	0.048 (0.052)	−4.249 *** (−2.888)	−0.051 (−0.516)	−0.240 * (−1.682)
Size	0.002 (0.619)	0.007 (1.423)	0.014 *** (4.350)	0.028 *** (6.217)
Lev	−0.017 *** (−3.596)	−0.137 *** (−18.078)	−0.040 *** (−9.182)	−0.195 *** (−30.900)
Staff	−0.010 *** (−3.211)	0.023 *** (4.439)	−0.019 *** (−6.017)	0.025 *** (5.507)
Age	0.005 (0.692)	−0.008 (−0.813)	−0.008 (−1.313)	−0.018 ** (−2.078)
N	2198	2198	2197	2197
F	9.414 ***	65.292 ***	30.124 ***	171.386 ***
Adj.R^2	0.022	0.149	0.074	0.318

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *t*-Values are in parentheses.

5.4. Analysis by R&D Intensity

Elston and Audretsch [66] concluded that high-tech firms are particularly dependent on government support to fund their activities. Therefore, we divide the sample into two groups, low R&D intensity and high R&D intensity. By analyzing the descriptive statistics of Table A4, we find that enterprises with high levels of R&D intensity tend to receive more subsidies.

Table 11 shows the results of the analysis by R&D intensity. In the high-intensity group, characterized by more R&D inputs, the coefficient Sub is positive and significant, while it is not significant in the low-intensity group. The results show that government subsidy is a factor that stimulates R&D investment and financial performance only for higher levels of R&D intensity. Regardless of the level of R&D, the estimated coefficients of Sub × Own in both groups are not significant at the 5% level.

Table 11. Regression results of (5) and (6).

	Low R&D Intensity		High R&D Intensity	
Variable	**Model (5)**	**Model (6)**	**Model (5)**	**Model (6)**
Constant	0.034 *** (6.646)	−0.049 (−1.389)	−0.031 (−0.941)	−0.199 *** (−5.520)
Sub	0.010 (0.373)	0.037 (0.195)	0.976 *** (6.032)	0.800 *** (4.546)
Sub × Own	−0.012 (−0.355)	−0.132 (−0.581)	−0.070 (−0.358)	−0.344 (−1.613)
Size	−0.001 (−1.586)	0.012 *** (2.660)	0.014 *** (3.175)	0.025 *** (5.217)
Lev	−0.009 *** (−8.717)	−0.165 *** (−22.810)	−0.010 (−1.571)	−0.178 *** (−25.732)
Staff	−0.001 (−1.160)	0.021 *** (4.217)	−0.018 *** (−4.310)	0.025 *** (5.312)
Age	−0.001 (−0.928)	−0.021 * (−1.891)	0.010 (1.368)	−0.012 (−1.524)
N	2198	2198	2197	2197
F	22.385 ***	92.137 ***	13.146 ***	117.980 ***
Adj.R^2	0.055	0.199	0.032	0.242

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. t-Values are in parentheses.

6. Conclusions and Policy Implications

Considering the impact of ownership, we empirically test the relationship between government subsidies, R&D investment, and firm performance in China's manufacturing industry. We are also able to elucidate the role of government subsidies in different types of enterprises. The findings allow us to offer various contributions to the literature on government subsidies and R&D management.

We confirm that government subsidies have a positive impact on private R&D investment and the performance of manufacturing enterprises, which substantiates the fact that the government has an important role in China's transition economy. Moreover, SOEs can receive more subsidies than POEs, which indicates that there are some preferences and unfairness in government subsidies. By taking ownership into consideration, this study reveals that the impact of government subsidies on R&D investment is stronger in POEs than in SOEs.

In additional analyses, we also find that the impact of government subsidies on private R&D and firm performance varies across industries and in different regions. Government subsidies can improve private R&D and firm performance regardless of the level of subsidy intensity. However, only for high-level R&D intensity can government subsidies stimulate enterprises' R&D activities and performance.

There are several limitations in this study. First, we do not further examine the impact of government subsidies on enterprises' R&D investment and performance based on different subsidy types. Second, other factors (e.g., industry background and political connections) affecting the relationship between government subsidies, R&D investment, and firm performance should be taken into consideration. Therefore, further research on the subject appears warranted.

Our empirical findings provide some policy implications. For managers/owners of POEs, and especially for managers/owners of POEs with low levels of R&D intensity, we suggest (1) greater continuity of R&D investment and (2) employment of resources to ensure effective utilization of government subsidies. For managers/owners of SOEs, we suggest improving innovation efficiency and the management mechanism to build core competitiveness.

Our study shows that SOEs are likely to receive considerable government subsidies. This is necessary to strengthen the supervision of subsidies in manufacturing companies with political connections and reduce the possibility of executives' rent-seeking behavior through institutional improvement. Relevant government departments need to evaluate the efficiency of annual government subsidies and keep examining their usage.

The results show that the positive effect of government subsidies on R&D investment is more significant in POEs than in SOEs, thus the government should pay more attention to R&D activities of POEs, and subsidy policies can be partial to high-quality private enterprise projects.

The results also indicate that subsidies will improve the current performance of manufacturing companies. Therefore, manufacturing companies should effectively and efficiently make use of subsidies (e.g., interest rate subsidies to accelerate depreciation) to improve their production efficiency and technology transformation mechanism.

Considering the role of the Chinese government, we suggest that policy-makers create a series of incentive policies (e.g., tax incentives and R&D subsidies) to encourage manufacturing enterprises to make regular annual investments in R&D. It is also suggested that the Chinese government avoid the "Matthew effect"[11] when effectively implementing government subsidies [67]. In addition, the government should make different subsidy policies according to the backgrounds of different industries and economic situations of different regions [68].

Author Contributions: J.X. came up with the original idea for the manuscript. Y.S. was responsible for data collection. Z.J. carried out the analysis. All authors read and approved the submission.

Funding: This research was funded by the Soft Science Planning Fund (grant number 2013RKB01097) of Shandong Province, the Social Science Planning Fund (grant number QDSKL130148) of Qingdao, and the Social Science Project (grant number 1114Q01) of Qingdao Agricultural University.

Acknowledgments: The authors are grateful to Dong-Seob Song, Jae-Woo Sim, Yeo-hwan Kim, Sang-hun Kim, Feng Liu, Yang Bai, the editors, and the anonymous referees for valuable comments and suggestions. Any errors are entirely due to the authors.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Descriptive statistics by industry.

Variable (Mean)	Chemical Raw Material and Chemical Products	Medicine	Special-Purpose Machinery	Electrical Machinery and Equipment	Communications and Other Electronic Equipment
ROA	0.0354	0.0784	0.0303	0.0429	0.0421
RD	0.0237	0.0324	0.0421	0.0422	0.0637
Sub	0.0058	0.0061	0.0062	0.0078	0.0091
Size	9.5007	9.4768	9.5312	9.4589	9.4396
Lev	0.4192	0.3521	0.4442	0.4262	0.3810
Staff	3.3166	3.3928	3.3470	3.3215	3.3947
Age	1.1438	1.1877	1.1666	1.1724	1.1706
Own	0.39	0.33	0.42	0.19	0.34

Appendix B

Table A2. Descriptive statistics by region.

Variable (Mean)	Eastern Provinces	Central Provinces	Western Provinces
ROA	0.0454	0.0336	0.0334
RD	0.0372	0.0310	0.0272
Sub	0.0065	0.0074	0.0057
Size	9.4862	9.5553	9.6371
Lev	0.3984	0.4554	0.4797
Staff	3.3771	3.4716	3.5093
Age	1.1626	1.1748	1.1858
Own	0.25	0.52	0.59

Appendix C

Table A3. Descriptive statistics by subsidy intensity.

Variable (Mean)	Low Subsidy Intensity	High Subsidy Intensity
ROA	0.0408	0.0420
RD	0.0288	0.0404
Sub	0.0019	0.0113
Size	9.5640	9.4779
Lev	0.4320	0.4098
Staff	3.4192	3.4089
Age	1.1655	1.1709
Own	0.38	0.33

Appendix D

Table A4. Descriptive statistics by R&D intensity.

Variable (Mean)	Low R&D Intensity	High R&D Intensity
ROA	0.0373	0.0455
RD	0.0148	0.0543
Sub	0.0060	0.0072
Size	9.5966	9.4453
Lev	0.4751	0.3666
Staff	3.4954	3.3326
Age	1.1802	1.1562
Own	0.42	0.28

Notes:

1. These data are based on China Statistical Yearbook on Science and Technology, which is provided by the National Bureau of Statistics of China.
2. Ricardian equivalence provides an explanation for this crowding-out effect.
3. Government subsidy aims to stimulate enterprises' R&D activities, while enterprises' private R&D input aims to gain core competitiveness and economic profits. Thus, government subsidy indirectly affects the quality of R&D output.
4. In 2015, China's State Council announced the establishment of a national leading group to upgrade the country's manufacturing sector. One of the group's main responsibilities will be to plan and coordinate the overall work to raise the country's manufacturing power.
5. In 2012, all listed companies were required by the China Securities Regulatory Commission (CSRC) to disclose detailed information about R&D expenditure in their annual financial statements.
6. Market value for those firms is different from firms with only A shares.
7. ROA tells you what earnings were generated from invested capital (assets). ROA for public companies can vary substantially and will be highly dependent on the industry. This is why we use ROA as a comparative measure.

8. In 2016, the amount of R&D expenditure in these five industries accounted for almost half of the total R&D expenditure in the entire manufacturing industry. The amount of R&D expenditure in these five industries is 84.07 billion yuan, 48.85 billion yuan, 57.71 billion yuan, 110.24 billion yuan, and 181.10 billion yuan, respectively.
9. The eastern provinces are Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan; the central provinces are Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan; and the western provinces are Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, and Tibet.
10. In 2016, the amount of R&D expenditure in eastern, central, and western provinces was 1106.2 billion yuan, 267.02 billion yuan, and 194.43 billion yuan, respectively.
11. The Matthew effect, described in sociology, is a phenomenon sometimes summarized by the adage "the rich get richer and the poor get poorer."

References

1. Aschauer, D.A. Does public capital crowd out private capital? *J. Monetary Econ.* **1989**, *24*, 171–188. [CrossRef]
2. Agarwal, M.; Mitra, S. Role of government in trade and investment boom: Lessons from East Asia. *J. Econ. Policy Reform* **2010**, *13*, 285–304. [CrossRef]
3. Xu, X.; Yan, Y. Does government investment crowd out private investment in China? *J. Econ. Policy Reform* **2014**, *17*, 1–12. [CrossRef]
4. Xu, J.; Sim, J.W. Are costs really sticky and biased? Evidence from manufacturing listed companies in China. *Appl. Econ.* **2017**, *49*, 5601–5613. [CrossRef]
5. Connolly, M.; Li, C. Government spending and economic growth in the OECD countries. *J. Econ. Policy Reform* **2016**, *19*, 386–395. [CrossRef]
6. Ricardo, D. *Essay on the Funding System. The Works of David Ricardo*, McCulloch ed.; John Murray: London, UK, 1888.
7. Guellec, D.; Pottelsberghe, B.V. Does government support stimulate private R&D? *OECD Econ. Stud.* **1997**, *29*, 95–122.
8. Meuleman, M.; Maeseneire, W.D. Do R&D subsidies affect SMEs' access to external financing? *Res. Policy* **2012**, *41*, 580–591.
9. Luo, L.; Yang, Y.; Luo, Y.; Liu, C. Export, subsidy and innovation: China's state-owned enterprises versus privately-owned enterprises. *Econ. Polit. Stud.* **2016**, *4*, 137–155. [CrossRef]
10. Li, J.; Rugman, A.M. Real options and the theory of foreign direct investment. *Int. Bus. Rev.* **2007**, *16*, 687–712. [CrossRef]
11. Chen, Y.Y.; Young, M.N. Cross-border mergers and acquisitions by Chinese listed companies: A principal-principal perspective. *Asia Pac. J. Manag.* **2010**, *27*, 523–539. [CrossRef]
12. Lach, S. Do R&D subsidies stimulate or displace private R&D? Evidence from Israel. *J. Ind. Econ.* **2002**, *50*, 369–390.
13. Czarnitzki, D.; Hussinger, K. The Link between R&D Subsidies, R&D Spending and Technological Performance. Available online: https://ssrn.com/abstract=575362 or http://dx.doi.org/10.2139/ssrn.57536 (accessed on 17 February 2015).
14. Lee, E.Y.; Cin, B.C. The effect of risk-sharing government subsidies on corporate R&D investment: Evidence from Korea. *Technol. Forecast. Soc. Chang.* **2010**, *77*, 881–890.
15. Jiang, C.; Zhang, Y.; Bu, M.; Liu, W. The effectiveness of government subsidies on manufacturing innovation: Evidence from the new energy vehicle industry in China. *Sustainability* **2018**, *10*, 1692. [CrossRef]
16. Guellec, D.; Pottelsberghe, B.V. The impact of public R&D expenditure on business R&D. *Econ. Innv. New Technol.* **2003**, *12*, 225–243.
17. Wu, A. The signal effect of government R&D subsidies in China: Does ownership matter? *Technol. Forecast. Soc. Chang.* **2017**, *117*, 339–345.
18. Almus, M.; Czarnitzki, D. The effects of public R&D subsidies on firms' innovation activities: The case of eastern Germany. *J. Bus. Econ. Stat.* **2003**, *21*, 226–236.
19. Davidson, C.; Segerstrom, P. R&D subsidies and economic growth. *RAND J. Econ.* **1998**, *29*, 548–577.
20. González, X.; Jaumandreu, J.; Pazo, C. Barriers to innovation and subsidy effectiveness. *RAND J. Econ.* **2005**, *36*, 930–950.

21. Khandan, A.; Nili, M. Government interventions and the size of the informal economy. The case of Iran (1971–2007). *J. Econ. Policy Reform* **2014**, *17*, 71–90. [CrossRef]
22. Hewitt-Dundas, N.; Roper, S. Output additionality of public support for innovation: Evidence for Irish manufacturing plants. *Eur. Plan. Stud.* **2010**, *18*, 107–122. [CrossRef]
23. Busom, I. An empirical evaluation of the effects of R&D subsidies. *Econ. Innov. New Technol.* **2000**, *9*, 111–148.
24. Clausen, T.H. Do subsidies have positive impacts on R&D and innovation activities at the firm level. *Struct. Chang. Econ. Dyn.* **2009**, *20*, 239–253.
25. Goolsbee, A. Does government R&D policy mainly benefit scientists and engineers? *Am. Econ. Rev.* **1998**, *88*, 298–302.
26. Zúñiga-Vicente, J.Á.; Alonso-Borrego, C.; Forcadell, F.J.; Galán, J.I. Assessing the effect of public subsidies on firm R&D investment: A survey. *J. Econ. Surv.* **2014**, *28*, 36–67.
27. Wallsten, S.J. The effects of government-industry R&D programs on private R&D: The case of the small business innovation research program. *Rand J. Econ.* **2000**, *31*, 82–100.
28. Cheng, H.; Zhao, X. Size of enterprise, intensity of R&D, intensity of subsidies, and government subsidies performance: Empirical study on Zhejiang private science and technology enterprises. *Sci. Res. Manag.* **2008**, *29*, 37–43.
29. Yu, F.; Guo, Y.; Le-Nguyen, K.; Barnes, S.J.; Zhang, W. The impact of government subsidies and enterprises' R&D investment: A panel data study from renewable energy in China. *Energy Policy* **2016**, *89*, 106–113.
30. Zang, Z.P. Government subsidies, R&D investment and the performance of listed cultural companies-An empirical study based on the mediating effect of the panel data of 161 listed cultural companies. *East China Econ. Manag.* **2015**, *29*, 80–88.
31. Tõnurist, P. Framework for analysing the role of state owned enterprises in innovation policy management: The case of energy technologies and Eesti Energia. *Technovation* **2015**, *38*, 1–14. [CrossRef]
32. Chan, H.S.; Rosenbloom, D.H. Public enterprise reforms in the United States and the People's Republic of China: A drift towards constitutionalization and departmentalization of enterprise management. *Public Admin. Rev.* **2009**, *69*, S38–S45. [CrossRef]
33. Qu, J.; Cao, J.; Wang, X.; Tang, J.; Bukenya, J.O. Political connections, government subsidies and technical innovation of wind energy companies in China. *Sustainability* **2017**, *9*, 1812. [CrossRef]
34. Wang, D.; Sutherland, D.; Ning, L.; Wang, Y.; Pan, X. Exploring the influence of political connections and managerial overconfidence on R&D intensity in China's large-scale private sector firms. *Technovation* **2018**, *69*, 40–53.
35. Lee, C.W.J. Financial restructuring of state owned enterprises in China: The case of Shanghai Sunve Pharmaceutical Corporation. *Account. Org. Soc.* **2001**, *26*, 673–689.
36. O'Connor, N.G.; Deng, J.; Luo, Y.D. Political constraints, organization design and performance measurement in China's state-owned enterprises. *Account. Org. Soc.* **2006**, *31*, 157–177. [CrossRef]
37. Hou, Q.; Hu, M.; Yuan, Y. Corporate innovation and political connections in Chinese listed firms. *Pac.-Basin Financ. J.* **2017**, *46*, 158–176. [CrossRef]
38. Arqué-Castells, P. Persistence in R&D performance and its implications for the granting of subsidies. *Rev. Ind. Organ* **2013**, *43*, 193–220.
39. Beason, R.; Weinstein, D.E. Growth, economies of scale, and targeting in Japan (1955–1990). *Rev. Econ. Stat.* **1996**, *78*, 286–295. [CrossRef]
40. Bergström, F. Capital subsidies and the performance of firms. *Small Bus. Econ.* **2000**, *14*, 183–193. [CrossRef]
41. Tzelepis, D.; Skuras, D. The effects of regional capital subsidies on firm performance: An empirical study. *J. Small Bus. Enterp. Dev.* **2004**, *11*, 121–129. [CrossRef]
42. Tang, Q.Q.; Luo, D.L. Empirical analysis on government subsidy motivation and its effects. *Financ. Res.* **2007**, *6*, 149–163.
43. McKenzie, J.; Walls, W.D. Australian films at the Australian box office: Performance, distribution, and subsidies. *J. Cult. Econ.* **2013**, *37*, 249–269. [CrossRef]
44. Sun, W.; Gan, S. The impact of government subsidy on listed companies' R&D investment and performance in IT industry. *Econ. Probl.* **2014**, *35*, 83–88.
45. Zhang, H.; Li, L.; Zhou, D.; Zhou, P. Political connections, government subsidies and firm financial performance: Evidence from renewable energy manufacturing in China. *Renew. Energy* **2014**, *63*, 330–336. [CrossRef]

46. Lee, E.; Walker, M.; Zeng, C. Do Chinese government subsidies affect firm value? *Account. Org. Soc.* **2014**, *39*, 149–169. [CrossRef]
47. Desai, M.A.; Hines, J.R. Market reactions to export subsidies. *J. Int. Econ.* **2008**, *74*, 459–474. [CrossRef]
48. Girma, S.; Gong, Y.D.; Gorg, H.; Yu, Z.H. Can production subsidies explain China's export performance? Evidence from firm-level data. *Scand. J. Econ.* **2009**, *111*, 863–891. [CrossRef]
49. Yang, Y. Government Preference and the Optimal Choice of R&D Subsidy Policy: Innovation Subsidy or Product Subsidy? Available online: http://downloads.hindawi.com/journals/jam/2014/536370.pdf (accessed on 12 February 2014).
50. Tao, Q.; Sun, Y.; Zhu, Y.; Yang, X. Political connections and government subsidies: Evidence from financially distressed firms in China. *Emerg. Mark. Financ. Trade* **2017**, *53*, 1854–1868. [CrossRef]
51. Jacob, M.; Johan, S.; Schweizer, D.; Zhan, F. Corporate finance and the governance implications of removing government support programs. *J. Bank. Financ.* **2016**, *63*, 35–47. [CrossRef]
52. Lim, C.Y.; Wang, J.; Zeng, C. China's "Mercantilist" government subsidies, the cost of debt and firm performance. *J. Bank. Financ.* **2018**, *86*, 37–52. [CrossRef]
53. Zhang, H.; Zheng, Y.; Zhou, D.; Zhu, P. Which subsidy mode improves the financial performance of renewable energy firms? A panel data analysis of wind and solar energy companies between 2009 and 2014. *Sustainability* **2015**, *7*, 16548–16560. [CrossRef]
54. Einiö, E. R&D subsidies and company performance: Evidence from geographic variation in government funding based on the ERDF population-density rule. *Rev. Econ. Stat.* **2014**, *96*, 710–728.
55. Czarnitzki, D.; Thorwarth, S. Productivity effect of basic research in low-tech and high-tech industries. *Res. Policy* **2012**, *41*, 1555–1564. [CrossRef]
56. Falk, M. Quantile estimates of the impact of R&D intensity on firm performance. *Small Bus. Econ.* **2012**, *39*, 19–37.
57. Shleifer, A.; Vishny, R. *The Grabbing Hand: Government Pathologies and Their Cures*; Harvard University Press: Cambridge, MA, USA, 1998.
58. Megginson, W.; Netter, J. From state to market: A survey of empirical studies on privatization. *J. Econ. Lit.* **2001**, *39*, 321–389. [CrossRef]
59. Saeed, A.; Belghitar, Y.; Clark, E. Do political connections affect firm performance? Evidence from a developing country. *Emerg. Mark. Financ. Trade* **2015**, *52*, 1876–1891. [CrossRef]
60. Ling, L.; Zhou, X.; Liang, Q.; Song, P.; Zeng, H. Political connections, overinvestments and firm performance: Evidence from Chinese listed real estate firms. *Financ. Res. Lett.* **2016**, *18*, 328–333. [CrossRef]
61. Lee, M.H.; Hwang, I.J. Determinants of corporate R&D investment: An empirical study comparing Korea's IT industry with its non-IT industry. *ETRI J.* **2003**, *25*, 258–265.
62. Zhu, P.; Xu, W. On the impact of government's S&T incentive policy on the R&D input and its patent output of large and medium-sized industrial enterprises in Shanghai. *Econ. Res. J.* **2003**, *6*, 45–53.
63. Qiu, L.; Chen, Z.Y.; Lu, D.Y.; Hu, H.; Wang, Y.T. Public funding and private investment for R&D: A survey in China's pharmaceutical industry. *Health Res. Policy Syst.* **2014**, *12*, 27. [PubMed]
64. Zhao, J.W.; Yin, C.B.; Niu, M.J. Spatial-temporal difference and trends of agricultural eco-civilization level in China. *Financ. Trade Res.* **2017**, *28*, 47–57.
65. Fan, Q.; Han, M.C. The impact of government R&D subsidy on the performance of national and regional independent innovations. *J. Ind. Eng. Eng. Manag.* **2011**, *25*, 183–188.
66. Elston, J.A.; Audretsch, D.B. Financing the entrepreneurial decision: An empirical approach using experimental data on risk attitudes. *Small Bus. Econ.* **2011**, *36*, 209–222. [CrossRef]
67. Antonelli, C.; Crespi, F. The 'Matthew effect' in R&D public subsidies: The Italian evidence. *Technol. Forecast. Soc. Chang.* **2013**, *80*, 1523–1534.
68. Boeing, P. The allocation and effectiveness of China's R&D subsidies: Evidence from listed firms. *Res. Policy* **2016**, *45*, 1774–1789.